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Original Article

Self-efficacy and its relationship to selected sport psychological constructs in the prediction of performance in ironman triathlon

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ABSTRACT

Heazlewood I, Burke S. Self-efficacy and its relationship to selected sport psychological constructs in the prediction of performance in ironman triathlon. *J. Hum. Sport Exerc.* Vol. 6, No. 2, pp. 328-350, 2011. The focus of this study was to apply this approach to an Ironman™ (3.8km swim, 180km cycle, and 42.2km run) triathlon event. The methodology utilized physiological measures (VO_{2max}, adiposity, height, weight), history of performance and sport psychological constructs (self-efficacy, motivation, sport confidence, cognitive and somatic anxiety) to predict total performance time and individual swim, cycle and run performance times. The results, utilizing correlation, regression and path analysis indicated that performance can be predicted more accurately when variables are assessed from a variety of Human Movement domains. The correlation analysis indicated only outcome orientations ($r=0.68$, $p<0.001$) and performance orientation ($r=0.70$, $p<0.001$) were significantly correlated with triathlon performance as compared to the non-predictive value of the CSAI-2 component of somatic anxiety, the attribution variables of internal, luck and powerful others, and history of previous performance. The path model explained a significant 44% of the variance of race performance. An investigation of the mediation of efficacy on performance in the race revealed that when direct paths were drawn from self-estimations to performance, non-significant regression weights were reported for the indirect paths to predict performance. **Key words:** PATH ANALYSIS, SPORT, PSYCHOLOGY, PERFORMANCE.

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INTRODUCTION

Sport psychological factors have been identified as potentially important in enhancing triathlon performance, however the role in predicting triathlon performance have been based on recommendations from general sport psychology (Baker & Sedgwick, 2005), some interventions based on imagery, relaxation and self-talk having a positive effect on race times for gymnasium triathlon (Thelwell & Greenless, 2001, 2003), qualitative differences based on active thoughts for expert as compared to passive unrelated thoughts of middle of pack and back of pack ultra endurance triathletes (Baker et al., 2005) and gender differences in attributions for triathlon performance.

Coaching manuals for triathlon participation (Mora, 2009; Gandolfo, 2005) address specific psychological components and the potential value of these constructs in enhancing triathlete performance separately. Sport specific psychological manuals (Baker & Sedgwick, 2005) have also become available. However, these recommendations do not always have an empirical foundation and there appears to have been no systematic research to link the sport psychological constructs simultaneously, or to predict triathlete performance based on this integrated approach. This suggested approach should more realistically reflect the multilevel responses that actually occur in humans when they train and compete.

There is a perception with athletes and coaches, as well as spectators, that self-confidence is a necessary quality for successful sporting performance. Self-confidence is also one of the most frequently cited psychological factors in the sport and exercise science literature and has been referred to as the most critical cognitive factor in sport (Feltz, Short, Sullivan, 2005).

The construct of self-efficacy has provided the impetus for research studies across a number of domains. Self-efficacy describes the belief one has in being able to execute a specific task to obtain a certain outcome (Bandura, 1997). It is not concerned with the skills an individual has but rather with the judgments of what one can do with whatever skills he or she possesses. Self-efficacy, then, can be considered a situationally specific self-confidence (Feltz, 1988a). Self-efficacy is theorized to influence the activities individuals choose to approach, the effort the), expend on such activities, and the degree of persistence they demonstrate in the face of failure or aversive stimuli (Bandura, 1997). More specifically, the greater the efficacy, the greater the pursuit of challenge, and the higher the goal striving.

Bandura's (1977) theory of self-efficacy has been the most extensively used theory for investigating self-confidence in sport and motor performance. This theory, developed within the framework of a social cognitive theory (Bandura, 1986a), poses self-efficacy as a common cognitive mechanism for mediating people's motivation and behaviour. People's judgment of their capability to perform at given levels affect their behaviour (i.e., choice of activities, effort expenditure, persistence), their thought patterns, and their emotional reactions in demanding or anxiety-provoking situations. Self-efficacy is a major determinant of behaviour when proper incentives and the necessary skills are present.

Self-Efficacy Measures

Bandura (1997) noted that disparities in observed relationships between self-efficacy beliefs and action might stem from assessment deficiencies. He advocated a micro-analytic approach that involved measuring efficacy in terms of particularized judgments of capability that vary across realms of activity, under different levels of task demands within a given activity domain, and under different situational circumstances. Accordingly, self-efficacy measures are usually constructed by listing a series of tasks, often varying in difficulty, complexity, stressfulness or some other dimension depending on the particular function being explored (Bandura, 1986). In this approach, individuals are asked whether they can perform at specific levels for a specific task (responses are either "yes" or "no"). Then they provide the degree of confidence (or strength of their response) for those items designated as "yes" (usually rated on a 100-point probability scale from total uncertainty to total certainty) for each level (Moritz, Feltz, Fahrbach & Mack, 2000). Common among all the measures in our research is the definition of self-efficacy as a judgment about what one thinks one can do not the skills one has.

Competitive State Anxiety Measure

The Competitive State Anxiety Inventory-2 (CSAI-2) was developed by Martens, Vealey & Burton (1990) to assess cognitive and somatic components of competitive state anxiety and self-confidence in relation to competitive sport performance. The instrument is a 27-item self-report test designed to measure three relatively independent competitive states. These are cognitive state anxiety, somatic state anxiety, and confidence.

Attribution Theory

Attribution theory according to Weiner (1985), is a cognitive appraisal approach to motivation. It assumes that individuals strive to explain, understand, and predict events based on their cognitive perceptions and appraisals, such as internality, powerful others and luck, which influence level of attainment in cognitive, affective or motor tasks. Heider's (Weinberg & Gould, 2011) basic formulation suggests that outcomes are attributed to the person (personal force) or to the environment (environmental force) or to both. McCready & Long (1985) developed an inventory that assessed these outcomes, of internality, powerful others externality, and chance externality.

VO_{2max} has been used extensively as a predictor of endurance performance for endurance athletes. Researchers have found VO_{2max} to be a relatively good predictor of performance especially when used in conjunction with other information such as body composition, muscle fibre type, muscle strength and muscle efficiency (Faria, 1984). High heterogeneity of VO_{2max} values within a group increases the relationship of VO_{2max} with the quality of performance (Dengel, Flynn, Costill & Kirwin, 1989). Thus it appears that although a high VO_{2max} may be important, it is only one of a multitude of factors affecting performance.

Physiological constructs have been identified to partially predict triathlon performance. These predictions have been based upon correlation analysis, (Butts, Henry & McLean, 1991; Dengel et al., 1989) and to a much lesser extent on multiple linear regression analysis (Sleivert & Wenger, 1993).

Of the numerous researchers examining triathlon performance (Dengel, Flynn, Costill & Kirwan, 1989; O'Toole, Hiller, Crosby & Douglas, 1987; Roalstad, 1989; Butts, Henry & McLean, 1991) most have utilised univariate techniques of analysis within a unidimensional approach, i.e., examining only physiological variables. The use of both multivariate techniques and multidimensional designs has been recommended to enhance the possibilities of performance prediction, whether performance is operationalised in terms of differences between successful/qualifier – nonsuccessful / nonqualifier or in terms of some direct measurement of ability.

The aim of the study was to assess a more comprehensive set of sport psychological and physiological constructs that have the potential to influence and predict triathlon performance, such as VO_{2max}, adiposity, sports confidence, self-efficacy, attribution and different dimensions of sport trait and state anxiety.

MATERIAL AND METHODS

The sample consisted of four hundred and sixteen triathletes who competed in various distance triathlons and had been in regular triathlon training for their competitive season for at least 10 months prior to the study. The dependent variable was Ironman™ Triathlon performance (minutes).

Anthropometric Protocol
Measures of body height, body weight and percentage body fat were taken during the testing session. Both height and weight were assessed on a Height and Weight Measuring Device (Mercury Scale Company, Therburton South Australia, Model #211FP). Body fat percentage was determined using skinfolds measured at four sites (triceps, biceps, subscapular, and suprailiac) using the Lange Skinfold Calliper (Cambridge Scientific Industries, Maryland USA Model #3008239). Percentage body fat was calculated by the summing of these sites and referring to the tables prepared by deVries & Housh (1994). This method in estimating adiposity is recognised as being very accurate with errors of +/- 3% for females and +/- 5% for males.

VO_{2max} Protocol
Participants completed an incremental step loaded test to volitional exhaustion on a "Lifecycle" aerobic trainer following the guidelines of deVries & Housh (1994). They were verbally encouraged throughout the test to continue working as long as possible. The pedaling cadence was 80 rpm. The 18 minute 'Hill Profile' program was selected for all participants, along with the level selection outlined in the test manual. After a 5 minute warm-up phase each participant progressed through the 'Hill Profile' to volitional exhaustion (no longer capable of maintaining a pedal cadence of 80 rpm for a 30 second period).

Cardiorespiratory data was collected with a 'P. K. Morgan Gas Analyser' to determine the fractional concentrations of CO_2 and O_2. The oxygen and carbon dioxide gas analysers were calibrated prior to each test with a standard gas mixture. The respiration transducer to assess gas volumes was calibrated with a one litre volumetric syringe. The accuracy of this instrument is rated at +/- 1%, and it is significantly more accurate than other inferential estimation methods such as those based on the Astrand-Rhyming Nomogram (Wilmore, Costill & Kenney, 2008). Heart rate was monitored by a Medeci Cardiac Monitor in the laboratory with electrodes placed at the left subclavicular, right subclavicular and 5 cm directly below the subjects left nipple positions.

The predictive variables of race time were sport trait and state confidence, causal attributions, competitive state anxiety (self-confidence, somatic anxiety, cognitive anxiety), self-efficacy, and previous performance for a Half-Ironman Triathlon (minutes). These psychological variables were measured by the Trait Sport Confidence Inventory (TSCI), State Sport Confidence Inventory (SSCI), Attributions Scale (luck, internality powerful others), Competitive State Anxiety (CSAI-2: self-confidence, somatic anxiety, cognitive anxiety), pre-event self-estimations of performance by Prediction Scale One (Outcome Orientation) and Prediction Scale Two (Performance Orientation).

Following Bandura's recommendations, a hierarchy of questions that reflected increasing degrees of difficulty measured the level of the triathletes outcome and performance self-efficacy. One outcome self-efficacy question asked, "How certain are you of placing in the top 750 finishers?" Similar questions asked how certain subjects were of placing in the top 600, 450, 300, 150, 50, and 10. A performance self-efficacy question asked, "How certain are you of finishing in under 15 hours?" Similar questions asked how certain subjects were of finishing in under 14 hours, 13 hours, 12 hours, 11 hours, 10 hours, 9 hours 30 minutes, 9 hours, and 8 hours 30 minutes. The subjects indicated their degree of confidence or certainty of achieving each level by choosing a percentage from *high uncertainty* (0) to *certainty* (100). Finally, self-efficacy scores were determined by adding strength scores (0 to 100) and dividing by the number of levels (questions) for the separate outcome self-efficacy and performance self-efficacy scores.

A variation on the correlational nature of this and previous research is the longitudinal design which involves two or more measurements of variables in a study taken on the same group of participants across time (Spector, 1981). The aim was to extend the investigation of the Ironman Triathlon (independent variable) and utilise a longitudinal design required sampling triathletes in races that served as selection events (during the season) for the Ironman (towards the end of the season). Permission was sought and received from the race organisers to set up a distribution stand within the bike check-in area during the compulsory equipment check on the afternoon before race day. These two races of similar distances (2 km swim; 80 km cycle; & 20 km run) provided athletes with the opportunity of qualifying for the Ironman and for those triathletes who have qualified preparation for the Ironman.

The second phase of the research design, that catered for the longitudinal nature of this investigation, required those triathletes that qualified form Triathlon 1a and Triathlon 1b to the Australian Ironman Championships Triathlon 1c an opportunity to participate. The postal system was utilised to send the instrumentation to the participants two weeks before the race date and only those returned before race day were included in the data set.

Weinberg & Gould (2011) have highlighted the need for field setting based investigations and that the testing of theories has been a neglected area of research in sport psychology. Research examining the influential effects of various sources of efficacy information has provided support for Bandura's theory in that individual efficacy expectations for motor performance have been found to be partially dependent upon performance accomplishments, vicarious experiences, and to a lesser extent verbal persuasion and physiological arousal. However, the majority of the research has failed to examine the causal relationships of self-efficacy because the research has inferred causality from correlational relationships. When causal modelling has been used, most models have excluded key variables identified as influencing performance, or the theoretical framework used to hypothesise relationships was not based on social cognitive theory. The longitudinal research design employed in this study permitted the examination of the influence that mental states have on performance and each other, and the influence previous performance has on subsequent mental states and performance.

Conceptual Model

The first conceptual model (Figure 1) proposed that the participants' previous performance; pre-competitive perceived variables of somatic and cognitive state anxiety; luck, internality and powerful others; and sport confidence would predict performance in a triathlon event (triathlon a) through pre-competitive prediction total (self-estimations) and a self-efficacy prediction scale. It was proposed that repeating this process with another sample and event (triathlon b) would allow greater opportunity to examine the relationships among the variables. It should be noted that these two events were Half-Ironman triathlons, which had leg distances of a 2 km swim; 80 km cycle; & 20 km run. The second conceptual model (Figure 2) involved targeting those performers from race a & b who competed in another event (triathlon c) later in the same triathlon season. Variables examined in the first model were re-examined in the second model.

For the current models the variables previous performance, Competitive State Anxiety (CSAI-2) - somatic anxiety (CSAI-som), Competitive State Anxiety (CSAI-2) - cognitive anxiety (CSAI-cog), Trait Sport Confidence Inventory (TSCI), Attribution Scale (luck, internal, and powerful others) were treated as exogenous variables and were assumed to be caused by factors outside the model that were not directly assessed. The variables State Sport Confidence Inventory (SSCI), Competitive State Anxiety (CSAI-2) - self-confidence (CSAI-sc), prediction total (self-estimations), prediction scale, and performance were specified as endogenous variables. Abbreviations (a, b & c) were used to identify the specific triathlon events.

The relationships of these constructs with triathlon performance were assessed by correlation, multiple linear regression and finally, more complex interactions via direct and indirect effects on triathlon performance via path analysis. Path diagrams and coefficients were derived using AMOS Version 3.61 (Arbuckle, 1997) software to evaluate model fit.

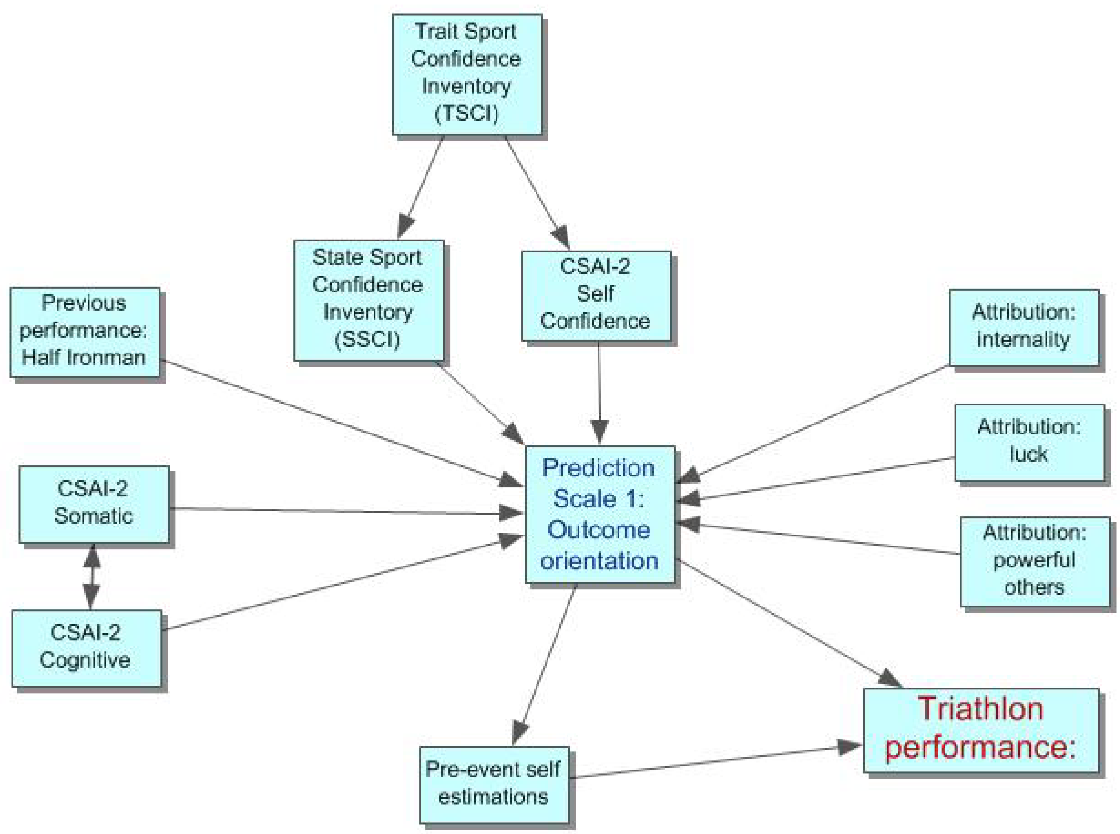

Figure 1. *Display the recursive conceptual models (Conceptual Model 1).*

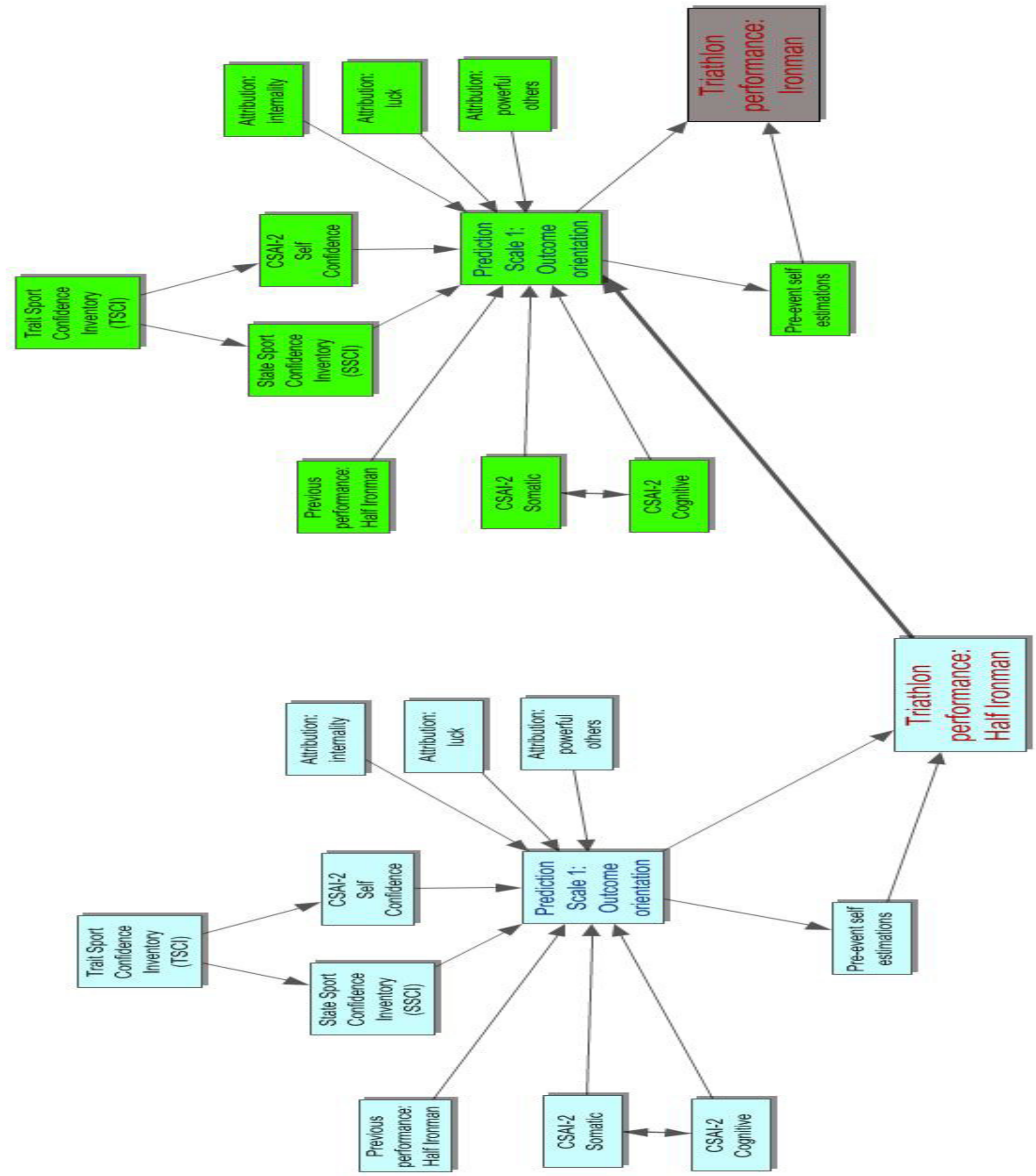

Figure 2. *Display the recursive conceptual models (Conceptual Model 2).*

RESULTS

Study 1 involved two separate Ironman races (Race 1 and 2) held 12 months apart. The results, displayed in Table 1, report the means, standard deviations, F-ratios and alpha values when race 1 data are compared to the race 2 data. The ANOVA analyses indicated that the measured variables were not significantly different.

***Table 1**. Table of means (M), standard deviations (SD), F ratios and Alpha values for all commonly measured variables in Race 1 and Race 2.*

Variable	Race 1 M	Race 1 SD	Race 2 M	Race 2 SD	F-ratio	*P* -value
Age (Yrs)	32.4	7.8	33.6	8.2	0.52	0.47
Skinfold (%)	15.4	4.4	16.0	5.6	0.30	0.59
Weight (kg)	73.2	8.1	72.6	9.7	0.10	0.75
VO_{2max} (ml/kg/min)	63.2	11.7	64.3	8.3	0.28	0.60
Performance History (min)						
Sri Chimnoy Result	295.4	30.2	281.9	36.4	2.93	0.09
Self-Efficacy						
S/E Swim (min)	73.5	13.8	63.9	9.8	13.4	0.00*
S/E Cycle (min)	359.9	29.8	346.3	35.2	3.5	0.06
S/E Run (min)	253.3	40.9	243.8	39.2	1.2	0.28
S/E Total (min)	688.8	74.1	649.5	74.2	5.8	0.02*
Prediction Scale #1	80.5	10.7	81.7	11.0	0.45	0.08
Prediction Scale #2	85.0	11.5	86.7	11.7	0.51	0.09
Anxiety (Trait)						
Cognitive	15.7	5.3	16.3	5.0	0.24	0.63
Somatic	14.2	3.6	14.0	3.8	0.05	0.83
Self-Confidence	26.8	5.1	26.6	5.2	0.06	0.82
Anxiety (State)						
Cognitive	15.4	4.8	16.3	4.7	0.63	0.43
Somatic	16.5	5.5	15.9	5.1	0.20	0.65
Self-Confidence	26.9	5.8	25.2	5.7	1.28	0.26
Attribution						
Internality	27.5	2.3	25.7	3.1	8.73	0.001*
Powerful Others	8.9	2.2	9.4	3.1	0.68	0.41
Luck	11.0	3.2	12.4	4.2	2.70	0.10
Sport Confidence						
Trait	84.0	17.0	87.5	13.7	1.06	0.31
State	87.5	16.5	88.4	13.4	0.09	0.77
Performance						
Swim	71.6	11.8	64.1	8.0	11.60	0.001*
Cycle	371.0	35.2	347.2	31.9	10.28	0.001*
Run	274.4	37.7	262.2	42.0	1.82	0.18
Total	716.5	70.8	673.6	71.8	7.10	0.01*
Place (position)	318.6	137.9	343.3	201.4	0.39	0.53

** Not significant when adjusted using the Bonferonni correction*

All subjects in this study had obtained a finishing time for the Sri Chimnoy Triathlon (performance history). This race was held eight (8) weeks before the Ironman™.

The Pearson product moment correlation coefficients and level of significance for selected variables and Ironman performance are presented Table 2

***Table 2**. Pearson product moment correlation coefficients and level of significance for Ironman performance.*

	Performance (min)	
Variables	r	p
Age	0.3075	0.164
Skinfold	0.2249	0.314
Weight	0.3763	0.084
VO_{2max}	-0.6641	0.001
Height	0.0805	0.722
Sri Chimnoy	0.7604	0.003
Self-Efficacy		
S/E Swim (min)	0.6951	0.000
S/E Cycle (min)	0.7427	0.000
S/E Run (min)	0.8663	0.000
S/E Total (min)	0.8971	0.068
Task Specific		
Outcome Orientation	-0.596	0.000
Performance Orientation	-0.461	0.000
Anxiety (Trait)		
Cognitive	0.0590	0.799
Somatic	0.2703	0.236
Self-Confidence	-0.0057	0.980
Anxiety (State)		
Cognitive	0.0917	0.801
Somatic	0.3293	0.353
Self-Confidence	0.2196	0.542
Attribution		
Internality	0.0577	0.804
Powerful Others	0.4675	0.033
Luck	-0.1479	0.522
Sport Confidence		
Trait	-0.1842	0.424
State	-0.3108	0.170

The task specific self-efficacy scales, both outcome *(Adj R^2 = 0.34, p < 001, b=-0.60)* and performance orientation *(Adj R^2 = 0.19, p < 01, b=0.-46)*, were significantly related to performance when multiple regression analyses (MR) was used to determine their specific individual relationships. High intercorrelation (r = 0.72, p < 0.001) existed between the two task specific self-efficacy scales. A stepwise MR that examined the combined predictive strength of these scales and performance revealed the outcome orientation scale predicted all of the relationship *(Adj R^2 = 0.34, p < 0.001, b=-0.60)*. The triathletes' own predictions of their performance correlated more strongly with actual scores than with the Self-efficacy scales.

Multiple regression analyses were used to determine the relative predictive strength of the significant variables. The results revealed that although both task specific self-efficacy scales (outcome and performance) were significantly related to performance, their total explained variance was insignificant when examined with a block and stepwise MR with self-estimations scores.

When total self-estimation score was the only variable entered into a MR, as a predictive variable and the residuals were analysed, it is interesting to note that the majority of participants over-estimated their times to complete the event (n=39 over estimated times and n=9 under estimated times). This indicated that the triathletes stated that they would complete the event in a longer time than they actually did complete the event. The implication of this finding will be addressed in the discussion. However, it must be emphasised that the triathletes were still capable of accurately predicting (self-estimation) their actual times (multiple R = 0.81, Adjusted R^2 = 0.652, ± 6.3% error of prediction) for the total event.

Table 3 displays the results of the stepwise multiple regression probability of *F*-to-enter (p = 0.05), and probability of *F*-to-remove (p = 0.10) to create various equations to predict performance.

Table 3. *Stepwise regression equations to predict performance time.*

Independent Variable	B	SE B	Multiple R	Adjusted R^2
Equation 1. PHYSIOLOGICAL VARIABLES (SE = 49.2)				
VO_{2max}	-3.11	0.77	0.67	0.44
Skinfold	2.91	1.13	0.74	0.52
Constant (min)	823.75	70.92		
Equation 2. SELF-EFFICACY VARIABLES (SWIM, CYCLE, & RUN) (SE = 42.2)				
Self Swim	2.46	0.68	0.76	0.56
Self Run	0.74	0.25	0.82	0.64
Constant (min)	346.15	48.31		
Equation 3. SELF-EFFICACY VARIABLES (SWIM, CYCLE, RUN, & TOTAL) (SE = 41.1)				
Self Total	0.81	0.97	0.82	0.66
Constant (min)	157.45	67.36		
Equation 4. SELF-EFFICACY (SWIM, CYCLE, & RUN) + OTHER PSYCHOLOGICAL VARIABLES (SE = 39.8)				
Self Swim	2.48	0.64	0.76	0.57
Self Run	0.71	0.23	0.82	0.66
State-Confidence	-0.93	0.41	0.84	0.68
Constant (min)	433.50	59.70		
Equation 5. PERFORMANCE HISTORY (Sri Chimnoy) (SE = 42.3)				
Sri Chimnoy	1.94	0.24	0.81	0.64
Constant (min)	144.84	71.77		
Equation 6. SRI CHIMNOY+ SELF-EFFICACY VARIABLES (SWIM, CYCLE, RUN, & TOTAL) (SE = 36.0)				
Self Total	0.48	0.13	0.82	0.66
Sri Chimnoy	1.06	0.31	0.87	0.74
Constant (min)	72.31	64.18		
Equation 7. SRI CHIMNOY + PHYSIOLOGICAL VARIABLES + PSYCHOLOGICAL VARIABLES EXCEPT SELF-EFFICACY (SE = 34.57)				
Sri Chimnoy	1.55	0.26	0.81	0.64
Weight	1.86	0.74	0.85	0.70
Luck	4.37	1.81	0.87	0.74
VO_{2max}	-1.34	0.64	0.89	0.76
Constant (min)	157.88	122.85		
Equation 8. SRI CHIMNOY + PHYSIOLOGICAL VARIABLES + SELF-EFFICACY VARIABLES + OTHER PSYCHOLOGICAL VARIABLES (SE = 32.0)				
Self Total	0.47	0.11	0.82	0.66
Sri Chimnoy	1.07	0.28	0.87	0.76
Weight	2.11	0.68	0.90	0.80
Constant (min)	-80.05	74.90		

A review of the intercorrelations between the independent variables in equation 8, revealed a correlation of 0.76 (p < 0.001) for self total and Sri Chimnoy. In an attempt to deal with this multicollinearity, a separate regression analysis was carried out with self total and Sri Chimnoy as a single computed variable. The results of this equation were the same as for equation 8. An examination of the residual plots revealed no patterns that would be suggestive of a significant lack of fit for these models.

The mean, standard deviation, F-ratios and alpha values for each variable assessed in study 1a are and study 1b are displayed in Table 4.

Table 4. *Table of means (M), standard deviations (SD), F-ratios and Alpha values for Study 1a and Study 1b.*

	Study 1a		**Study 1b**		F-ratio	*P* -value
Variable	M	SD	M	SD		
Age (Yrs)	32.4	7.8	32.4	7.8	0.01	0.97
Performance History (min)						
Half-Ironman Events	290.3	34.6	303.1	36.6	0.18	0.67
Self-Efficacy						
S/E Swim (min)	35.0	5.8	35.0	6.8	1.53	0.22
S/E Cycle (min)	171.3	19.1	172.2	19.5	0.87	0.36
S/E Run (min)	104.2	14.9	103.6	14.5	0.43	0.52
S/E Total (min)	309.6	32.9	308.1	34.5	1.86	0.18
Prediction Scale #1	58.9	17.9	57.4	18.5	0.32	0.82
Prediction Scale #2	62.3	16.4	64.0	16.0	0.39	0.72
Anxiety (State)						
Cognitive	15.7	4.5	15.6	4.8	0.82	0.80
Somatic	15.1	4.6	14.2	3.5	2.01	0.24
Self-Confidence	25.2	5.7	25.7	5.5	0.80	0.82
Attribution						
Internality	26.1	3.6	26.5	4.4	0.21	0.62
Powerful Others	14.8	1.9	14.6	1.8	0.26	0.61
Luck	13.0	4.1	12.5	4.6	0.15	0.77
Sport Confidence						
Trait	82.5	15.8	81.5	17.6	0.25	0.62
State	83.0	17.4	83.1	17.3	0.08	0.85
Performance						
Total	309.4	33.5	293.2	29.9	1.42	0.24

The differences between study 1a and study 1b were assessed by applying a series of ANOVAs. Essentially no significance differences were identified, which indicated that the two samples were very similar. Table 4 indicates the mean, the standard deviation, the F-ratio and the alpha value or level of significance for each variable for study 1a and study 1b. These results allowed the data from these two events to be pooled.

The Assessment of the 'Efficacy Scales'

The performance orientation self-efficacy scale was the only scale that was significantly related to performance, in each of the three races when multiple regression analyses (MR) was used to determine their specific individual relationships. The specific results for race a *Adj* $R^2 = 0.27$, $F(2,413) = 78.42$, $p < 001$; race b *Adj* $R^2 = 0.21$, $F(2,413) = 54.72$, $p < 001$ and race c *Adj* $R^2 = 0.20$, $F(2,413) = 54.24$, $p < 001$. High intercorrelations (range from $r = 0.65$ to 0.90, $p < 0.001$) existed between the two task specific self-efficacy scales. The Pearson product moment correlations are reported in Table 5.

Table 5. Correlations among the 'Efficacy Scales' and performance.

Performance	Race a	b	c
Task Specific			
Outcome Orientation	-0.58	-0.59	-0.68
Performance Orientation	-0.60	-0.72	-0.70

all correlations were significant p < 0.001

The mean, standard deviation, and range for each variable assessed in study 1c are displayed in table 6.

Table 6. Table of Means (M), Standard Deviations (SD) and range for all variables in Study 1c.

Variable	M	SD	Range
Age (Yrs)	32.4	7.8	19-62
Self-Efficacy			
S/E Swim (min)	68.4	9.1	53-110
S/E Cycle (min)	355.2	34.0	285-480
S/E Run (min)	251.8	31.8	195-360
S/E Total (min)	676.3	64.3	556-875
Prediction Scale #1	46.4	16.8	10-85.7
Prediction Scale #2	48.7	13.7	11-80
Anxiety (State)			
Cognitive	16.3	5.2	9-30
Somatic	14.6	4.6	9-33
Self-Confidence	26.0	5.9	9-36
Attribution			
Internality	26.8	2.9	15-30
Powerful Others	14.9	1.7	9-20
Luck	12.9	4.6	6-30
Sport Confidence			
Trait	84.0	17.7	13-117
State	85.9	18.7	13-117
Performance			
Overall Time (min)	690.6	67.4	567-902

The reliability of each multi-item scale was examined by means of Cronbach's alpha. Alpha coefficients and other descriptive indices were determined for the two Prediction Scales (#1 Outcome Orientation and #2 Performance Orientation), TSCI, SSCI, CSAI-2 and the attribution scale. For all scales, internal consistency reliability estimates ranged from 0.81 to 0.96. These estimates indicate that each scale reliably assessed the associated constructs.

Consistent with previous research (Weinberg & Gould, 2011) comparison of descriptive statistics for the precompetitive anxiety patterns of endurance athletes in this sample with CSAI-2 norms revealed that these triathletes were moderately low on both cognitive (*M* = 16.3) and somatic (*M* = 14.6) anxiety for the Ironman event (race c). A reverse trend was recorded for the Half-Ironman event (race a & b) with cognitive (*M* = 15.6) and somatic (*M* = 16.7) anxiety.

Path Analysis
A path analysis was conducted to test the relationships embedded in self-efficacy theory with respect to the present data. Specifically, this analysis tested a conceptual model to explain the theoretical relationships among self-efficacy, sport confidence, CSAI-2 subcomponents, attributions and performance based on the concept of performance expectations.

A data set was constructed of participants who had successfully completed race c from either race a or race b and their values were pooled into one set for the analysis. Figures 3 and 4 show the conceptual models displaying the parameter estimates. It should be noted that the estimates are displayed in relatively fixed locations in the path diagrams. Their positions are assigned according to the rules (AMOS Ver 3.61, Arbuckle, 1997).

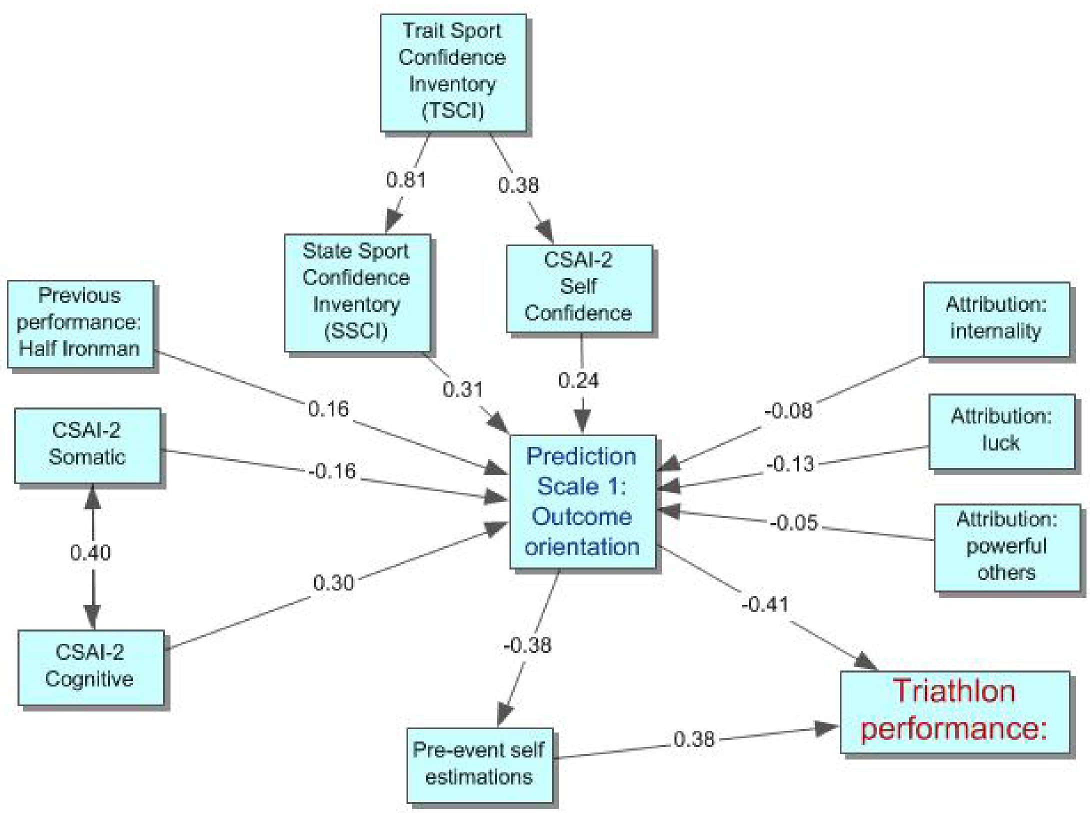

Figure 3. *Conceptual Model 1 (Standardised estimates).*

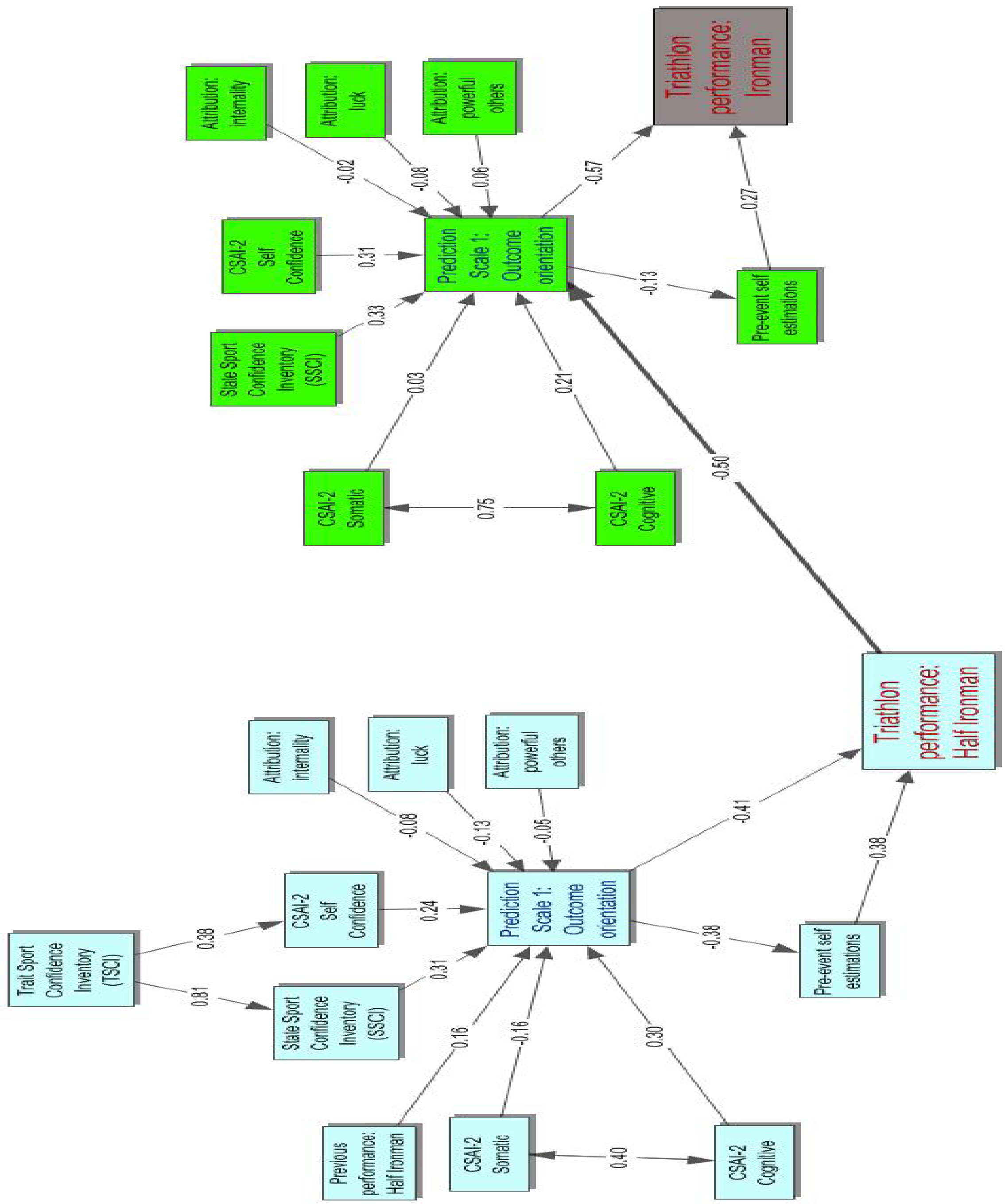

Figure 4. *Conceptual Model 2 (Standardised estimates).*

The results of the overall ‘fit indices’ for conceptual model 1 are presented in Table 7. A significant chi-square indicated that the model did not fit the data well, though the overall fit indices confirm a relatively satisfactory model fit.

Table 7. *Goodness-of Fit Measures for the Conceptual Model 1.*

Goodness-of fit measures	**Value**
Chi-square (df=52)	152.93 (*p*< 0.000)
GFI	0.832
AGFI	0.748
PGFI	0.555

The results of the overall ‘fit indices’ for conceptual model 2 are presented in Table 8. Similar findings revealed a significant chi-square which indicates that the model did not fit the data well. Once again, the overall fit indices confirm a relative satisfactory model fit.

Table 8. *Goodness-of Fit Measures for the Conceptual Model 2.*

Goodness-of fit measures	**Value**
Chi-square (df=203)	712.89 (*p*< 0.000)
GFI	0.614
AGFI	0.519
PGFI	0.493

A consistent finding across the events was the nonsignificant value of the CSAI-2 component of somatic anxiety, the attribution variables of internal, luck and powerful others, and history of previous performance.

An investigation of the mediation of the efficacy scale on performance in each of the races revealed that when directed paths were drawn from self-estimations to performance, nonsignificant regression weights were reported for the indirect paths to predict performance. It should be stressed that this results was found for each of the two races. Additional support for this result is that though the ‘efficacy scale’ was significantly related to performance the Adj R^2 values from the MR analysis ranged from 0.20 to 0.27.

Results showed that state self-confidence, using both the anxiety self-confidence sub-scale and sport self-confidence scale, was predicted by the trait measure of self-confidence. These were the only variables related to the prediction of self-efficacy.

Importantly, the path model explained 44% of the variance in race a and 44% in race c. This result highlights the predictive strength of the analysis because race a and race c were of differing lengths. So that this observation can be investigated further, an additional step in the path analytic process is required. The conceptual model fit indices suggested a poor fit and the researcher made a decision regarding how to delete and add paths in the model. A specification search (Schumacker & Lomax, 1996) was conducted to alter the original model in the search for a model that is ”best fitting” in some sense and yields parameters having practical significance and substantive meaning. Based on the parameter estimates of the conceptual model, nonsignificant variables (<1.96 critical ratio) were removed from the analysis. This subsequent analysis produced a parsimonious or ‘reduced’ model (Figures 9 & 10) displaying only those paths that were shown to be nonzero (Arbuckle, 1997).

The results of the overall ‘fit indices’ for the parsimonious model 1 are presented in Table 9. A non-significant chi-square indicated that the model did fit the data well and the overall fit indices confirm a satisfactory model fit.

Table 9. *Goodness-of Fit Measures for the Parsimonious Model 1.*

Goodness-of fit measures	**Value**
Chi-square (df=8)	10.08 (p< 0.260)
GFI	0.970
AGFI	0.921
PGFI	0.369

The results of the overall ‘fit indices’ for the parsimonious model 2 are presented in Table 10. A non-significant chi-square indicated that the model did fit the data well and the overall fit indices confirm a satisfactory model fit.

Table 10. *Goodness-of Fit Measures for the Parsimonious Model 2.*

Goodness-of fit measures	**Value**
Chi-square (df=25)	24.85 (p< 0.470)
GFI	0.958
AGFI	0.880
PGFI	0.574

An additional method to obtain a satisfactory model is to modify the rejected model in small ways to improve its fit to the data. The AMOS program $Mods command produces suggestions that will likely result in lower chi-square values. This was carried out but no lower values for the chi-square were derived from this analysis.

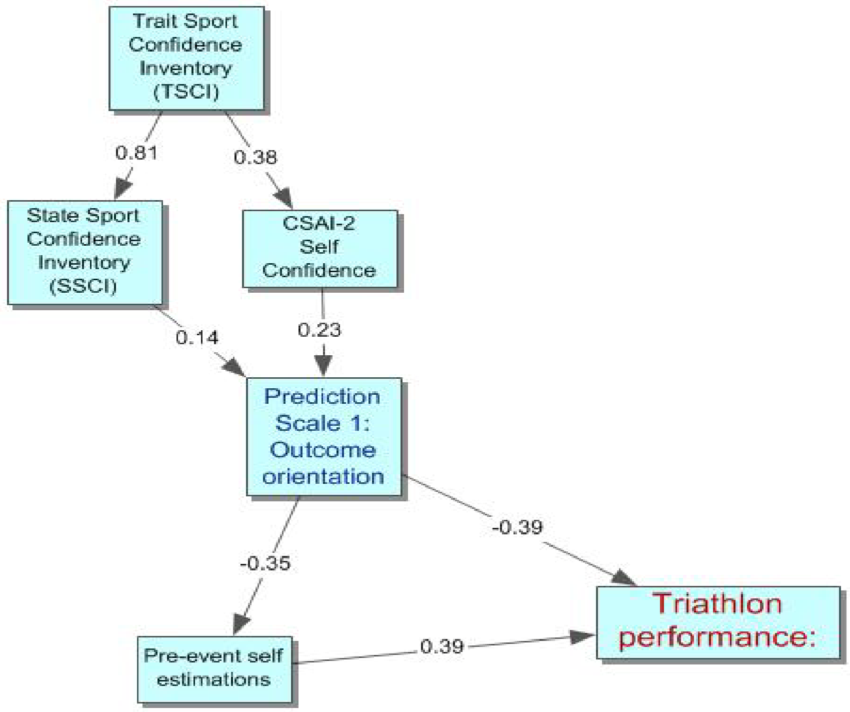

Figure 5. *Parsimonious Model 1 (Standardised estimates).*

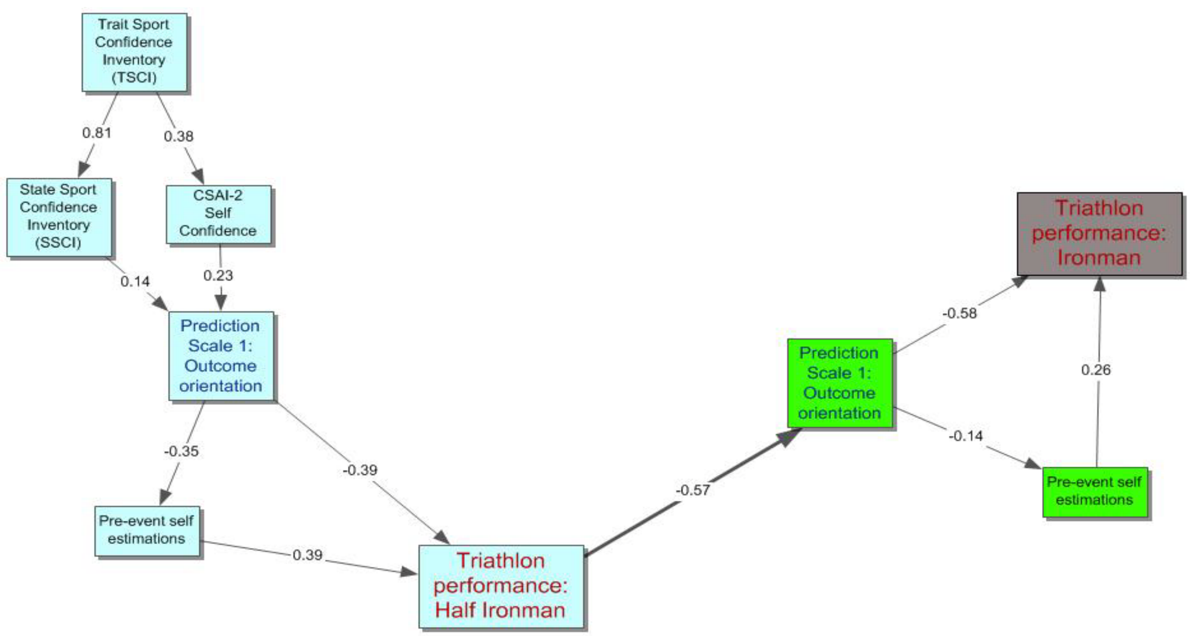

Figure 6. Parsimonious Model 2 (Standardised estimates).

DISCUSSION

Though it has been acknowledged that no previous investigation has examined the selected psychological and physiological variables together with a triathlete sample, an attempt has been made to compare the descriptive statistics of the psychological and physiological variables with previous research. Jones, Swain & Cale (1990), examining middle-distance runners and Martens et al. (1990) examining cycling, found similar results to the CSAI-2 data reported in Table 1.

The results reported by Gayton & Nickless (1987), which administed the TSCI and SSCI (Vealey, 1986) with a group of 24 marathon runners compared favourably with the established norms found in Vealey's (1986, 1988) original work. These results are the same as the results reported in Table 1.

When all the psychological variables (CSAI-2, STAI, SSCI & TSCI, but excluding the self-efficacy statements) were entered into the analysis, all these constructs failed to predict total times. However, when consideration is given to triathlon performance history and self efficacy statements the ability to predict performance times, far greater accuracy was achieved in predicting total time. In this model three items explained 74% of the performance variation. This relationship between competitive self-efficacy total and performance history is expressed in equation 6.

Though results were reported for the legs of the triathlon (swim, cycle and run) and they do reveal insight into the self-efficacy theoretical domain, this discussion will focus its analyses on total performance time. The current emphasis, from a sports science perspective, promotes the view that a triathlon is a single event and is not one that is made up of three separate sport disciplines.

The result that the majority of participants over-estimated their times to complete the event suggests that there was a higher perceived probability of failure than a probability of success according to achievement motivation theory (Weinberg & Gould, 2011). The concept of failure in this context is on a ratio level spectrum of failure which was only marginally below the actual times achieved in the event. It should be noted that there was not a nominal level concept of success or failure, such as finished the race or did not finish the race. It must be emphasised that the triathletes were still capable of accurately predicting their actual times (multiple $R = 0.81$, Adjusted $R^2 = 0.652 \pm 6.3\%$ error of prediction) for the total event.

The set of predictive variables were established through Pearson product correlation analysis and multiple linear regression analysis. The specific hierarchy of statistically significant variables established by correlation analysis for this study were self-efficacy total, self-efficacy swim, self-efficacy run, VO_{2max}, self-efficacy cycle, skinfold/adiposity, causal attribution-luck and age. The order of importance from the block and stepwise multiple linear regression analyses were the self-efficacy scores and VO_{2max}. In this study the importance of self efficacy was identified as the most significant and predictive construct followed by the exercise physiological constructs of maximal oxygen consumption and adiposity.

Assessment of 'Efficacy Scales'

The purpose of this investigation was to investigate Self-Efficacy Measurement, in a competitive ultraendurance triathlon setting, using measures that are sensitive to the orientation of performance and outcome and to explore the relationships between these measures and performance in an Ironman™ Triathlon. The actual predictions of performance (self-estimations) made by the triathletes, were more accurate predictors of triathlon performance

The performance orientation self-efficacy scale was the only scale that was significantly related to performance, in each of the three races when multiple regression analyses (MR) was used to determine their specific individual relationships. High intercorrelations existed between the two task specific self-efficacy scales.

Assessment of Conceptual Model
In terms of the testing of self-efficacy theory, the present study allowed the investigation to remove ambiguity concerning the direction of causality via the use of path analysis. According to Bandura's self-efficacy theory, it was hypothesised self-efficacy affects subsequent performance both directly and indirectly through its effects on past performance. The results of the path analysis indicated that self-efficacy and past performance operated as determinants of triathlon performance in these events.

A specification search (Schumacker & Lomax, 1996) was conducted to alter conceptual model 1 and 2 in the search for a model that was "best fitting" in some sense and yields parameters having practical significance and substantive meaning. As noted previously, this procedure allows nonsignificant variables (<1.96 critical ratio) to be removed from the analysis. The results of the overall 'fit indices' for the parsimonious model indicated that the model did fit the data well and the overall fit indices confirm a satisfactory model fit.

The relationship between anxiety and athletic performance is one of the most widely discussed issues in sport and exercise psychology but the most difficult to pin down. In conceptual analyses, what begins as anxiety quickly fades into general arousal, psychic energy, or mental alertness or gets carved up into foreboding thoughts, somatic activity and tense behaviour. Despite innumerable studies, the empirical issue remains just as unsettled as the conceptual one. Anxiety over athletic activities is often attributed to trait anxiety. Competitive situations presumably activate the personality trait, which then arouses anxiety that impairs performance. Therefore, much attention in the literature is devoted to reducing anxiety. This study did not provide evidence to support this view. What ever effects physiological arousal might have are likely to depend more on how much attention is paid to it and whether it is interpreted as being psyched up or as being distressed (Weinberg & Gould, 2011). Level of autonomic arousal was not related to performance, although perceived autonomic arousal was related to efficacy beliefs. To the extent that perceived arousal affects performance, it does so indirectly through the influence of efficacy belief. This study provides evidence to support the causality of efficacy beliefs influencing both anxiety and performance but that anxiety does not contribute independently to performance. The competitive setting of distance running is similarly predicted by efficacy belief but not by anxiety level (Martin & Gill, 1991). This pattern of results suggests that efficacy beliefs enhance athletic performance mainly by affecting motivation and thought processes.

The issue of past performance in causal analyses warrants brief comment. In studies in which individuals perform the same routine in rapid succession, efficacy beliefs contribute independently to performance, but adding prior performance increases the predictiveness of subsequent performance. The research paradigm used in the two studies provided evidence that performance is not a cause of performance. Performance will correlate with one another to the extent that their determinants are the same on the different occasions. As long as the underlying determinants remain unspecified, knowing that prior performance predicts subsequent performance says nothing about causation. The aim of the current research was to advance the understanding of psychosocial contributors to triathlon performance by a systematic analysis of its multiple determinants. Such analysis is achieved by extracting the various sociocognitive determinants from the conglomerate set that governs performance and assessing their relative contribution. The more determinants that are removed from the conglomerate, the greater the predictive shrinkage of past performance as it becomes the proxy residue of fewer and fewer remaining determinants. A judgment on the success of this research will highlight its attempt in shifting attention from performance as a determinant of itself to the actual determinants of performance.

Bandura (1986) hypothesised that self-efficacy beliefs mediate the effect of other determinants of performance on subsequent performance; that is, when these determinants are controlled, self-efficacy judgments are better predictors of performance. Bandura also argued that constructs such as self-concept, perceived usefulness, and anxiety are "common mechanism" of personal agency in the sense that they, like self-efficacy beliefs, also influence outcome. However, these mechanisms are, to a great extent, the result of self-efficacy judgments - their influence is largely due to the confidence with which individuals approach a task. Consequently, although strong correlational relationships are observed between these mechanisms and related outcomes, the relationships are mostly due to the influence of self-efficacy on the common mechanisms. Self-efficacy judgments mediate the effects of prior experience on the common mechanisms; that is, when prior experience are controlled, self-efficacy is a strong predictor not only of a related outcome but of common mechanisms such as anxiety, confidence, and attribution.

CONCLUSION

The purpose of this study is to discover whether self-efficacy beliefs play the mediational role ascribed to them by Bandura (1986) and social cognitive theory, and whether these beliefs are stronger predictors of performance than are other presumed determinants and common mechanisms. The focus on the influence of self-efficacy on triathlon was founded on a broader interest in athletes and athletic performance. The results would nevertheless inform social cognitive theory and its claims about self-efficacy in general.

The results indicate that fewer misleading interpretations will occur when using methodologies that allows for investigation of the possible hierarchical relationships among variables and performance than from studies that fail to test for causal relationships.

The results of the path analysis was consistent with earlier causal studies in motor performance in that self-efficacy was found to be an effect of performance (Feltz, 1988; Feltz & Mugno, 1983). Feltz & Mugno (1983) also found that the influence of performance on self-efficacy increased over time, while the influence of self-efficacy on performance decreased over time.

The support found for Bandura's (1977) model under such a variable environment provides support to the utility of self-efficacy theory in actual sport settings. As previously noted, most of the previous research examining the causal elements in Bandura's model have employed nonathletic populations engaging in novel tasks under controlled conditions (e.g. Feltz, 1988; McAuley, 1985). Other studies have examined athletes performing in competitive settings, but examined only the correlational relationships between self-efficacy and performance. Still other studies have undertaken causal investigations of athletes performing in contrived situations (Fitzsimmons et al., 1991; Haney, 1991). The present study examined the causal relationships hypothesised in Bandura's model, using athletes competing in their chosen sport, and replicated the causal and mediational effects of self-efficacy on performance found in controlled settings. Field based support for the causal mechanism of self-efficacy theory had been missing in the literature relating to sport and motor performance prior to the present investigation.

Task specific measures of self-efficacy (outcome and performance) did display criterion and predictive validity. The actual predictions of performance (self-estimations) made by the triathletes, were more accurate predictors of triathlon performance. The establishment of a set of predictive variables, concurrent validity and predictive validity indicates that this study was successful in understanding those sport psychological constructs that are related to triathlon performance.

Results of this study also demonstrated that analyses such as path analyses or structural equation modelling are required if substantive questions are to be more clearly answered. When simpler correlational or multiple regression analyses were used, the plethora of significant relationships may have led to conclusions that would have been both unclear and misleading.

Based on these findings coupled with practical applications to triathlon sport psychology training, the sources of confidence may fall into three broad areas. First, athletes gain confidence from ‘achievement’, which includes both mastery and demonstration of ability. Second, athletes gain confidence from ‘self-regulation’, which includes physical/mental preparation and physical self-presentation. Third, athletes, gain confidence from a positive and achievement-nurturing ‘climate’, which includes the sources of social support, coaches’ leadership, vicarious experience, environmental comfort, and situational favourableness. That is, athletes gain confidence when they achieve their goals, engage in effective self-regulation of cognitions and behaviour, and train and compete in a competitive climate that is supportive, challenging, comfortable, and motivating. Future research should continue to engage in field-based, causal investigations that examine athletes competing in their chosen activities.

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